[0078] It should be noted that the above-mentioned equations, modules or functions can be implemented in any kind of computing devices, including general-purpose computers such as personal computers, work stations and main frame computers, and ASICs (Application Specific Integrated Circuits).

[0079] In an embodiment a general-purpose computer is employed to implement the invention. The general-purpose computer comprises software representing the above-mentioned equations, modules or functions. The software is preferably contained in computer readable mediums. Computer readable mediums include read only memories, random access memories, hard disks, flexible disks, compact disks and so on.

[0080] Simulations

[0081] A very simple simulation of the tracking system is carried out to illustrate some of the concepts proposed in the description.

[0082] A simulation illustrating the tracking characteristics of the proposed method without acceleration estimates of the reference trajectory, is provided. In particular, the double support phase of the biped system during a squatting maneuver was simulated. The results are illustrated in FIGS. **7** to **9**.

[0083] In **FIG. 7**, the desired and simulated joint trajectories illustrate the effectiveness of the tracking procedure. These results were obtained by setting a=0, i.e. no acceleration estimates were used as inputs to the inverse model. The corresponding joint torques and ground reaction forces are depicted in **FIG. 8** and **FIG. 9**, respectively.

[0084] It should be noted that those skilled in the art can modify or change the above-mentioned embodiments, without departing from the scope and spirit of the present invention. It should therefore be noted that the disclosed embodiments are not intended to limit the scope of the invention, but only to exemplarily illustrate the invention.

What is claimed is:

1. A simulation system for a combined musculoskeletal and augmentation device system including segments and joints connecting the segments, the simulation system comprising;

a dynamics model of the combined musculoskeletal and augmentation device system, receiving computed torques at the joints as inputs and delivering simulated kinematic data of the segments as outputs;

an augmentation device controller for control of the augmentation device, receiving the simulated kinematic data as inputs and delivering assist torques as outputs;

an inverse dynamics module for the musculoskeletal and augmentation device system, receiving the simulated kinematic data, desired kinematic data of the segments and the assit torques as inputs and delivering the computed torques; and

a muscle force and muscle capacity module for checking and adjusting the raw computed torques from the inverse module, receiving the raw computed torques as inputs and delivering adjusted computed torques as outputs after verification of feasibility and adjustments.

2. A simulation system according to claim 1 wherein the muscle force and muscle capacity module deduces muscle forces from the computed torques, compares the muscle forces with maximum force limits and adjusts a muscle force if the muscle force exceeds a limit, to adjust the corresponding computed torque.

3. A simulation system according to claim 1 or **2** wherein muscle forces with and without the assist torques are compared in order to asses whether the assist torque control helps or hinders motion and if the assist torque control hinders motion the muscle forces are adjusted and feasible joint torques are computed.

4. A simulation system according to claim 2 or **3** wherein the muscle force and muscle capacity module deduces muscle forces based on a static optimization criterion in which a sum of muscle activation squared is minimized.

5. A simulation system according to any one of claims 1 to 4 wherein the inverse dynamics model obtains modified accelerations of kinematic data through non-linear feedback of the simulated kinematic data.

6. A simulation system according to **5**, wherein the kinematic data include position data, velocity data and acceleration data and the inverse dynamics model calculates modified accelerations of kinematic data, through non-linear feedback based on desired acceleration data, error between simulated position data and desired position data and error between simulated velocity data and desired velocity data.

7. A simulation system according to **5**, wherein the kinematic data include position data, velocity data and acceleration data and the inverse dynamics model calculates modified accelerations of kinematic data, through non-linear feedback based on error between simulated position data and desired position data and/or error between simulated velocity data and desired velocity data.

8. A simulation system according to **5**, wherein the feedback gains are selected to yield a critically damped response to produce the fastest possible non-oscillatory behavior.

9. A simulation system according to any one of claims 1 to 8, further comprising a ground reaction force model receiving the computed torques and the simulated kinematic data as inputs and delivering simulated reaction forces under the segments contacting the ground as outputs.

10. A simulation system according to any one of claims 1 to 9, wherein the augmentation device controller employs gravity compensation control algorithm in which the augmentation device controller obtains the assist torques to compensate for the forces due to gravity and alter the computed muscle torque due to the compensation for gravity.

11. A simulation system according to claim 10, wherein the augmentation device obtains change in the computed muscle torques, due to gravity assist control, using coordinates of the center of the mass of the segments.

12. A simulation system according to claim 11, wherein the augmentation device obtains the coordinates of the center of the mass of the segments, from measurements of joint angles and segment lengths.

13. A simulation system according to claim 10, wherein the augmentation device obtains change in the computed muscle torques, due to gravity assist control, using measured reaction forces under the feet.